CLAIMS

1. A multi-layered coiled hollow fiber bundle for use in a separation module, the bundle comprising:

a plurality of coiled hollow fibers, whereby the plurality of hollow fibers are arranged so as to create at least two layers, each layer of said bundle designed to provide a specific performance output when the bundle is contained in a housing and subjected to a fluid of a certain velocity such that Dean vortices are created.

2. The multi-layered coiled hollow fiber bundle of claim 1, wherein at least two layers have a performance output that is substantially equivalent when the bundle is contained in a housing and subjected to a fluid of a certain velocity such that Dean vortices are created.

3. The multi-layered coiled hollow fiber bundle of claim 1, wherein all hollow fibers in the bundle have substantially identical structure and polymeric components.

4. The multi-layered coiled hollow fiber bundle of claim 1, wherein all hollow fibers in the bundle have a substantially identical composition.

5. The multi-layered coiled hollow fiber bundle of claim 3, wherein each of the at least two layers of hollow fibers are characterized by a set of variables including the hollow fiber's outer and inner diameter, the number of fibers, the angle of coiling said fibers and the length of said fibers, whereby the variables of at least two layers of said bundle being selected so each such layer performs substantially equivalently to the other layers when the bundle is contained in a housing and subjected to a fluid of a certain velocity such that Dean vortices are created.

6. The multi-layered coiled hollow fiber bundle of claim 4, wherein each of the at least two layers of hollow fibers are characterized by a set of variables including the number of fibers, the angle of coiling said fibers and the length of said fibers, whereby the variables of each layer of said bundle being selected so each layer performs substantially equivalently to the other layers when the bundle is contained in a housing and subjected to a fluid of a certain velocity such that Dean vortices are

created.

7. The multi-layered coiled hollow fiber bundle of claim 1, wherein each of the at least two layers of hollow fibers are characterized by a set of variables including the length of a mandrel around which the fiber bundle will be coiled, the diameter of the mandrel and the number of the hollow fibers for each layer.

8. The multi-layered coiled hollow fiber bundle of claim 7, wherein the number of fibers selected for each layer is contingent upon minimizing gaps between the fibers.

9. The multi-layered coiled hollow fiber bundle of claim 1, wherein the fibers are arranged so as to maximize the packing density of the fibers in a module in which the fibers would be used.

10. The multi-layered coiled hollow fiber bundle of claim 1, wherein the bundle is part of a filtration module.

11. The multi-layered coiled hollow fiber bundle of claim 10, wherein the bundle is coiled around a mandrel.

12. A method for producing a multi-layered coiled hollow fiber bundle that is directly scalable from a single layer coiled hollow fiber bundle, the bundles for use in separation modules, the method comprising:

determining a performance parameter from a single layer coiled hollow fiber bundle contained in a housing and subjected to a fluid of a certain velocity such that Dean vortices are created,

determining the needed value of the variables for each additional layer so each additional layer would perform substantially equivalently to the first layer when the bundle is part of a filtration module and subjected to the fluid of the certain velocity; and

producing a multi-layered coiled hollow fiber bundle that incorporates the determined variables.

13. The method of claim 12, wherein the performance parameter is determined algorithmically.

14. The method of claim 12, wherein the performance parameter is determined empirically.

15. The method of claim 12, wherein the variables include the hollow fiber's outer and inner diameter, the number of fibers for the layer, the angle of coiling said fibers and the length of said fibers.

16. The method of claim 12, wherein the variables include the number of fibers for the layer, the length of the mandrel and the diameter of the mandrel.

17. The method of claim 12, wherein a bundle comprising 5 layers is produced.

18. The method of claim 12, wherein the fibers are arranged so as to maximize the packing density of the fiber bundle in a module in which the fibers would be used.

19. A method of manufacturing a multi-layered separation module suitable to produce Dean vortices, the method comprising:

selecting a mandrel having a predetermined diameter and length;

selecting a hollow fiber having a predetermined internal diameter (ID) and outer diameter (OD);

selecting a number of hollow fibers to comprise the layer;

selecting the winding angle with which the fibers would be wound around the mandrel;

winding the fibers around the mandrel at the pre-selected angle so as to form a layer of coiled hollow fibers; and

adjusting the length of said wound fibers to that of the mandrel so as to produce a first layer of said module having a certain performance parameter upon application of a measurable velocity of fluid having a measurable viscosity and a shear rate and

adjusting the fiber lengths, number of fibers, and winding angle of subsequent layers so the certain performance parameter of each subsequent layer is substantially

equivalent to that of the first layer.

20. The method of claim 19 further comprising potting the two ends of the multi-layered module.

21. The method of claim 19 further comprising inserting at least one multi-layered module into a housing.

22. A single-layered coiled hollow fiber separation module designed to provide an estimated performance output when a fluid of a known shear rate and at a pre-determined velocity that creates Dean vortices is filtered there through, the module comprising:
a layer of coiled hollow fibers, the hollow fibers characterized by a set of variables including the hollow fiber's outer and inner diameter, the number of fibers, the angle of coiling said fibers and the length of said fibers; and
a housing.

23. The single-layered coiled hollow fiber separation module of claim 22 further comprising a mandrel around which the fibers will be coiled of pre-determined variables, these variables including the length of the mandrel and the diameter of the mandrel.

24. The single-layered coiled hollow fiber separation module of claim 22, wherein the number of fibers selected for each layer is contingent upon minimizing gaps between the fibers.

25. The single-layered coiled hollow fiber separation module of claim 22, wherein the fibers are arranged so as to maximize the packing density.